

REMARKS

In accordance with the foregoing, claims 1, 12, 19, 33 and 38-41 have been amended and claim 32 has been cancelled without prejudice or disclaimer. Claims 1, 8-16, 19, 20, 33 and 36-41 are pending and under consideration. Claims 1, 12, 19, 33 and 38-41 are the independent claims. No new matter is presented in this Amendment.

CLAIM OBJECTION

Claim 1 is objected to because of the following informalities: "1,3-dioxolane" should recite "1,3-dioxolane".

Applicants have amended claim 1 in accordance with the Examiner's suggestion. Accordingly, Applicants respectfully request that the objection of claim 1 be withdrawn.

REJECTIONS UNDER 35 U.S.C. §112:

Claims 1, 8-16, 19, 20, 32, 33 and 36-41 are rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement.

Applicants have amended independent claims 1, 12, 19, 33 and 38-41 to correct the minor informalities noted by the Examiner.

Accordingly, Applicants respectfully assert that claims 1, 12, 19, 33 and 38-41, as amended, fully comply with the requirements of 35 U.S.C. §112, first paragraph, and therefore, request that the rejection of claims 1, 12, 19, 33 and 38-41, be withdrawn.

Regarding the rejection of claims 8-11, 13-16, 20, 36 and 37, it is noted that these claims were rejected because of their dependency from claims 1, 12 and 19.

However, as noted above, claims 1, 12 and 19, as amended, fully comply with the requirements of 35 U.S.C. §112, first paragraph, and therefore, Applicants respectfully request that the rejection of claims 8-11, 13-16, 20, 36 and 37, be withdrawn.

Regarding the rejection of claim 32, it is noted that claim 32 has been cancelled without prejudice or disclaimer and thus, the rejection of claim 32 is moot.

Claims 1, 8-11, 19, 20, 32, 33 and 36 are rejected under 35 U.S.C. §112, first paragraph, because the specification, while being enabling for a volume ratio of dimethoxyethane to sulfolane to 1,3-dioxolane of 3:1:1, does not reasonably provide enablement for a volume ratio of a weak polar solvent to a strong polar solvent to a lithium protection solvent of 3:1:1.

Applicants have amended independent claims 1, 19 and 33 to correct the minor informalities noted by the Examiner.

Accordingly, Applicants respectfully assert that claims 1, 19 and 33, as amended, fully comply with the requirements of 35 U.S.C. §112, first paragraph, and therefore, request that the rejection of claims 1, 19 and 33, be withdrawn.

Regarding the rejection of claims 8-11 and 20, it is noted that these claims were rejected because of their dependency from claims 1, 12 and 19.

However, as noted above, claims 1, 12 and 19, as amended, fully comply with the requirements of 35 U.S.C. §112, first paragraph, and therefore, Applicants respectfully request that the rejection of claims 8-11 and 20, be withdrawn.

Regarding the rejection of claim 32, it is noted that claim 32 has been cancelled without prejudice or disclaimer and thus, the rejection of claim 32 is moot.

Claims 12-16 and 37 are rejected under 35 U.S.C. §112, first paragraph, because the specification, while being enabling for a volume ratio of dimethoxyethane to sulfolane to 1,3-dioxolane of 2:2:1, does not reasonably provide enablement for a volume ratio of a weak polar solvent to a strong polar solvent to a lithium protection solvent of 2:2:1.

Applicants have amended independent claim 12 to correct the minor informalities noted by the Examiner.

Accordingly, Applicants respectfully assert that claim 12, as amended, fully comply with the requirements of 35 U.S.C. §112, first paragraph, and therefore, request that the rejection of claim 12, be withdrawn.

Regarding the rejection of claims 13-16 and 37, it is noted that these claims were rejected because of their dependency from claim 12.

However, as noted above, claim 12, as amended, fully complies with the requirements of 35 U.S.C. §112, first paragraph, and therefore, Applicants respectfully request that the rejection

of claims 13-16 and 37, be withdrawn.

Claim 38 is rejected under 35 U.S.C. §112, first paragraph, because the specification, while being enabling for a volume ratio of dimethoxyethane to sulfolane to 1,3-dioxolane of 20:16:4:10, does not reasonably provide enablement for a volume ratio of a weak polar solvent to a first strong polar solvent to a second strong polar solvent to a lithium protection solvent of 20:16:4:10.

Applicants have amended independent claim 38 to correct the minor informality noted by the Examiner.

Accordingly, Applicants respectfully assert that claim 38, as amended, fully complies with the requirements of 35 U.S.C. §112, first paragraph, and therefore, request that the rejection of claim 38, be withdrawn.

Claim 39 is rejected under 35 U.S.C. §112, first paragraph, because the specification, while being enabling for a volume ratio of dimethoxyethane to 2-methyltetrahydrofurane to sulfolane to 1,3-dioxolane of 16:4:20:10, does not reasonably provide enablement for a volume ratio of a first weak polar solvent to a second weak polar solvent to a strong polar solvent to a lithium protection solvent of 16:4:20:10.

Applicants have amended independent claim 39 to correct the minor informality noted by the Examiner.

Accordingly, Applicants respectfully assert that claim 39, as amended, fully complies with the requirements of 35 U.S.C. §112, first paragraph, and therefore, request that the rejection of claim 39, be withdrawn.

Claim 40 is rejected under 35 U.S.C. §112, first paragraph, because the specification, while being enabling for a volume ratio of dimethoxyethane to 3, 5-dimethylisoxazole to sulfolane to 1,3-dioxolane of 4:1:4:1, does not reasonably provide enablement for a volume ratio of a weak polar solvent to a first lithium protection solvent to a strong polar solvent to a lithium protection solvent of 4:1:4:1.

Applicants have amended independent claim 40 to correct the minor informality noted by

the Examiner.

Accordingly, Applicants respectfully assert that claim 40, as amended, fully complies with the requirements of 35 U.S.C. §112, first paragraph, and therefore, request that the rejection of claim 40, be withdrawn.

Claim 41 is rejected under 35 U.S.C. §112, first paragraph, because the specification, while being enabling for a volume ratio of dimethoxyethane to diglyme to sulfolane to 1,3-dioxolane of 2:2:1:5, does not reasonably provide enablement for a volume ratio of a first weak polar solvent to a second weak polar solvent to a strong polar solvent to a lithium protection solvent of 2:2:1:5.

Applicants have amended independent claim 41 to correct the minor informality noted by the Examiner.

Accordingly, Applicants respectfully assert that claim 41, as amended, fully complies with the requirements of 35 U.S.C. §112, first paragraph, and therefore, request that the rejection of claim 41, be withdrawn.

REJECTIONS UNDER 35 U.S.C. §103:

Claims 1, 8-16, 19, 20, 32, 33 and 36-40 are rejected under 35 U.S.C. §103(a) as being unpatentable over Evans et al. (U.S. Patent 4,302,520).

Applicants respectfully traverse this rejection for at least the following reason.

Regarding the rejection of independent claims 1 and 19, it is noted that claims 1 and 19 recite a lithium sulfur battery comprising, amongst other novel features, an electrolyte including a sulfur-containing electrolyte salt and mixed organic solvents; wherein the mixed organic solvents of said electrolyte consist of three different solvents, a weak polar solvent, which is capable of dissolving elemental sulfur, a strong polar solvent, which is capable of dissolving lithium polysulfide, and a lithium protection solvent, which forms a good protective layer on a lithium surface, wherein the weak polar solvent has a dielectric coefficient of less than 15 and consists of dimethoxyethane, the strong polar solvent consists of sulfolane, and the lithium protection solvent consists of 1,3-dioxolane, and wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

Evans discloses a non-aqueous cell utilizing an active metal anode, a cathode and a liquid organic electrolyte such as 3-methyl-2-oxazolidone in conjunction with a solvent and a selected solute (column 1, lines 7-14). The solvents used by Evans include cyclic ethers such as tetrahydrofuran and 1,3 dioxolane; monoethers such as diethyl ether; and cyclic sulfones such as sulfolane and others (column 4, lines 28-35). Therefore, Evans discloses weak polar solvents, strong polar solvents and lithium protection solvents. However, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest that the volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1. Furthermore, Evans fails to teach or suggest that the weak polar solvent has a dielectric coefficient of less than 15, as recited in independent claims 1 and 19.

Additionally, it is noted that the lithium-sulfur battery recited in independent claim 1 yields unexpected results since it has excellent sulfur utilization percentages, compared to conventional lithium-sulfur batteries. This can be evidenced by the results illustrated in Table 1 of the specification.

Accordingly, Applicants respectfully assert that the rejection of independent claims 1 and 19 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claims 1 and 19, as amended.

Furthermore, Applicants respectfully assert that dependent claims 8-11 and 36 and 20 and 32 are allowable at least because of their dependence from claims 1 and 19, respectively, and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 8-11 and 36 and 30 and 32 also distinguish over the prior art.

Regarding the rejection of independent claim 12, it is noted that claim 12 recites a lithium sulfur battery comprising, amongst other novel features, an electrolyte including a sulfur-containing electrolyte salt and mixed organic solvents, wherein the mixed organic solvents consist of three different solvents, a weak polar solvent, a strong polar solvent, and a lithium protection solvent, wherein the weak polar solvent consists of dimethoxyethane, the strong polar solvent consists of sulfolane, and the lithium protection solvent consists of 1, 3-dioxolane, and a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1.

As noted above, although Evans discloses strong and weak solvents and a lithium

protection solvent, Evans fails to teach or suggest the volume ratio of the mixed organic solvents, and in particular, Evans fails to teach or suggest a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1, as recited in independent claim 12.

Accordingly, Applicants respectfully assert that the rejection of independent claim 12 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 12, as amended.

Furthermore, Applicants respectfully assert that dependent claims 13-16 and 37 are allowable at least because of their dependence from claim 12 and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 13-16 and 37 also distinguish over the prior art.

Regarding the rejection of independent claim 33, it is noted that claim 33 recites a method of manufacturing a lithium-sulfur battery comprising, amongst other novel features, providing an electrolyte comprising a sulfur-containing electrolyte salt and mixed organic solvents, wherein the mixed organic solvents of said electrolyte consist of three different solvents, a weak polar solvent, which is capable of dissolving elemental sulfur, a strong polar solvent, which is capable of dissolving lithium polysulfide, and a lithium protection solvent, which forms a good protective layer on a lithium surface; and placing the electrolyte between the positive and negative electrode using a separator to form the lithium-sulfur battery, wherein the weak polar solvent has a dielectric coefficient of less than 15 and consists of dimethoxyethane, the strong polar solvent consists of sulfolane, and the lithium protection solvent consists of 1,3-dioxolane, and a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

As noted above, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest any method of manufacturing a lithium-sulfur battery. Furthermore, Evans fails to teach or suggest that the weak polar solvent has a dielectric coefficient of less than 15 and consists of dimethoxyethane, and a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1, as recited in independent claim 33.

Accordingly, Applicants respectfully assert that the rejection of independent claim 33 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each

feature of independent claim 33, as amended.

Regarding the rejection of independent claim 38, it is noted that claim 38 recites a lithium sulfur battery comprising, amongst other novel features, an electrolyte including a sulfur-containing electrolyte salt and mixed organic solvents; the mixed organic solvents consist of a weak polar solvent, first and second strong polar solvents, and a lithium protection solvent, wherein the weak polar solvent consists of dimethoxyethane, the first strong polar solvent consists of sulfolane, the second strong polar solvent consists of dimethylsulfoxide, and the lithium protection solvent consists of 1,3-dioxolane, and a volume ratio of the weak polar solvent to the first strong polar solvent to the second strong polar solvent to the lithium protection solvent is 20:16:4:10.

As noted above, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest volume ratios of the mixed organic solvents. In particular, Evans fails to teach or suggest that the volume ratio of the weak polar solvent to the first strong polar solvent to the second strong polar solvent to the lithium protection solvent is 20:16:4:10, as recited in independent claim 38.

Accordingly, Applicants respectfully assert that the rejection of independent claim 38 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 38, as amended.

Regarding the rejection of independent claim 39, it is noted that claim 39 recites a lithium-sulfur battery comprising, amongst other novel features, mixed organic solvents consisting of first and second weak polar solvents, a strong polar solvent, and a lithium protection solvent, wherein the first weak polar solvent consists of dimethoxyethane, the second weak polar solvent consists of methyltetrahydrofuran, the strong polar solvent consists of sulfolane, and the lithium protection solvent consists of 1,3-dioxolane, and a volume ratio of the first weak polar solvent to the second weak polar solvent to the strong polar solvent to the lithium protection solvent is 16:4:20:10.

As noted above, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest mixed organic solvents consisting of first and second weak polar solvents, a strong polar solvent, and a lithium protection solvent, and wherein

a volume ratio of the first weak polar solvent to the second weak polar solvent to the strong polar solvent to the lithium protection solvent is 16:4:20:10.

Accordingly, Applicants respectfully assert that the rejection of independent claim 39 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 39, as amended.

Regarding the rejection of independent claim 40, it is noted that claim 40 recites a lithium-sulfur battery comprising, amongst other novel features, mixed organic solvents consisting of a weak polar solvent, a strong polar solvent, and first and second lithium protection solvents, wherein the weak polar solvent consists of dimethoxyethane, the first lithium protection solvent consists of 3,5-dimethylisoxazole, the strong polar solvent consists of sulfolane, and the second lithium protection solvent consists of 1,3-dioxolane, and a volume ratio of the weak polar solvent to the first lithium protection solvent to the strong polar solvent to the second lithium protection solvent is 4:1:4:1.

As noted above, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest that the weak polar solvent consists of dimethoxyethane, the first lithium protection solvent consists of 3,5-dimethylisoxazole, the strong polar solvent consists of sulfolane, and the second lithium protection solvent consists of 1,3-dioxolane, and wherein a volume ratio of the weak polar solvent to the first lithium protection solvent to the strong polar solvent to the second lithium protection solvent is 4:1:4:1, as recited in independent claim 40.

Accordingly, Applicants respectfully assert that the rejection of independent claim 40 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 40, as amended.

Claims 1, 8-16, 19, 20, 32, 33 36 and 37 are rejected under 35 U.S.C. §103(a) as being unpatentable over Vourlis et al. (U.S. Patent 5,432,030).

Applicants respectfully traverse this rejection for at least the following reasons.

Regarding the rejection of independent claims 1 and 19, it is noted that claims 1 and 19 recite a lithium sulfur battery comprising, amongst other novel features, an electrolyte including a sulfur-containing electrolyte salt and mixed organic solvents; wherein the mixed organic solvents

of said electrolyte consist of three different solvents, a weak polar solvent, which is capable of dissolving elemental sulfur, a strong polar solvent, which is capable of dissolving lithium polysulfide, and a lithium protection solvent, which forms a good protective layer on a lithium surface, wherein the weak polar solvent has a dielectric coefficient of less than 15 and consists of dimethoxyethane, the strong polar solvent consists of sulfolane, and the lithium protection solvent consists of 1,3-dioxolane, and wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

Vourlis discloses an electrochemical cell employing an electrolyte comprising a mixture of 3-methyl-2-oxazolidone in a range of 27 to 33 percent by volume and a volume ratio of 1,3-dioxolane to 1,2-dimethoxyethane (abstract). Therefore, Vourlis discloses an electrolyte consisting of a strong polar solvent, a weak polar solvent and a lithium protection solvent. However, Vourlis fails to teach or suggest that the weak polar solvent has a dielectric coefficient of less than 15 and consists of dimethoxyethane, or that the strong polar solvent consists of sulfolane. Vourlis further fails to teach or suggest that the volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1, as recited in independent claims 1 and 19.

Additionally, it is noted that the lithium-sulfur battery recited in independent claim 1 yields unexpected results since it has excellent sulfur utilization percentages, compared to conventional lithium-sulfur batteries. This can be evidenced by the results illustrated in Table 1 of the specification.

Accordingly, Applicants respectfully assert that the rejection of independent claims 1 and 19 under 35 U.S.C. §103(a) should be withdrawn because Vourlis fails to teach or suggest each feature of independent claims 1 and 19, as amended.

Furthermore, Applicants respectfully assert that dependent claims 8-11 and 36 and 20 and 32 are allowable at least because of their dependence from claims 1 and 19, respectively, and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 8-11 and 36 and 30 and 32 also distinguish over the prior art.

Regarding the rejection of independent claim 12, it is noted that claim 12 recites a lithium sulfur battery comprising, amongst other novel features, an electrolyte including a sulfur-containing electrolyte salt and mixed organic solvents, wherein the mixed organic solvents

consist of three different solvents, a weak polar solvent, a strong polar solvent, and a lithium protection solvent, wherein the weak polar solvent consists of dimethoxyethane, the strong polar solvent consists of sulfolane, and the lithium protection solvent consists of 1, 3-dioxolane, and a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1.

As noted above, Vourlis discloses an electrolyte comprising a strong polar solvent, a weak polar solvent and a lithium protection solvent. However, as also noted above, Vourlis fails to teach or suggest that the weak polar solvent consists of dimethoxyethane, or that the strong polar solvent consists of sulfolane. Vourlis further fails to teach or suggest the volume ratios of the solvents and in particular, Vourlis fails to teach or suggest that the volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1, as recited in independent claim 12.

Accordingly, Applicants respectfully assert that the rejection of independent claim 12 under 35 U.S.C. §103(a) should be withdrawn because Vourlis fails to teach or suggest each feature of independent claim 12, as amended.

Furthermore, Applicants respectfully assert that dependent claims 13-16 and 37 are allowable at least because of their dependence from claim 12 and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 13-16 and 37 also distinguish over the prior art.

Regarding the rejection of independent claim 33, it is noted that claim 33 recites a method of manufacturing a lithium-sulfur battery comprising, amongst other novel features, providing an electrolyte comprising a sulfur-containing electrolyte salt and mixed organic solvents, wherein the mixed organic solvents of said electrolyte consist of three different solvents, a weak polar solvent, which is capable of dissolving elemental sulfur, a strong polar solvent, which is capable of dissolving lithium polysulfide, and a lithium protection solvent, which forms a good protective layer on a lithium surface; and placing the electrolyte between the positive and negative electrode using a separator to form the lithium-sulfur battery, wherein the weak polar solvent has a dielectric coefficient of less than 15 and consists of dimethoxyethane, the strong polar solvent consists of sulfolane, and the lithium protection solvent consists of 1,3-dioxolane, and a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

As noted above, Vourlis discloses an electrolyte comprising a strong polar solvent, a weak polar solvent and a lithium protection solvent. However, as also noted above, Vourlis fails to teach or suggest that the weak polar solvent consists of dimethoxyethane, or that the strong polar solvent consists of sulfolane. Vourlis further fails to teach or suggest the volume ratios of the solvents and in particular, Vourlis fails to teach or suggest that the volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1, as recited in independent claim 33.

Accordingly, Applicants respectfully assert that the rejection of independent claim 33 under 35 U.S.C. §103(a) should be withdrawn because Vourlis fails to teach or suggest each feature of independent claim 33, as amended.

CONCLUSION:

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.

Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 503333.

Respectfully submitted,

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